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EMBEDDED OPEN TOOLKITS FOR USER INNOVATION: POSTPONING NEW PRODUCT DEVELOPMENT DECISIONS INTO THE CUSTOMER DOMAIN

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EMBEDDED OPEN TOOLKITS FOR USER INNOVATION: POSTPONING NEW PRODUCT DEVELOPMENT DECISIONS INTO THE CUSTOMER DOMAIN

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Abstract
Postponement is an approach to reduce risk in new product development by delaying design decisions. Addressing the problem of elicitation and transferring customer needs, which proved to be sticky and difficult to transfer prior to product launch, this paper proposes to move the point of postponement into the customer domain. Products based on technologies such as embedded open toolkits enable customers to transfer their needs directly into possible product designs after purchasing. Therefore this paper provides an analysis of contingency factors and discusses strategic implications of postponing new product development decisions into the customer domain by using embedded open toolkits.

1. Introduction

A main challenge in new product development (NPD) is to match a new design to customer preferences. The better the fit between a product's design features and a user's preference set, the higher the perceived quality, and the lower the risk of an unsuccessful NPD project in form of a product flop. Recent reviews however show large failure rates in the commercialization of new designs [2], [6]. In most of the cases, the reason of failure has not been a lack of technological capability of the firm, but a wrong understanding of the real customer needs and demands. The reason is that customer need information often is sticky, difficult to explicit, and also frequently changes during the course of a longer NPD process. The idea of this paper is to investigate a new approach to reduce the NPD risk by postponing some design decisions into the customer domain. Following the successful example of open source software projects, which are characterized by high development flexibility and good fit of the design with the users' requirements, the idea is to develop a method which enables customers to directly transfer their needs into a product specification after having purchased the product. Fundamental element of this process is an intelligent interface that helps product users to make their specifications when already owning the product.
In the concept of embedded open toolkits for user innovation (in the following: "embedded toolkits"), a manufacturer designs a product with build-in flexibility by embedding knowledge and

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rules about possible product differentiations into the product. This set of rules has to be large enough to widen solution space and make an embedded toolkit more than just a configuration tool. Trough an embedded toolkit products can be modified within the defined solution space during the whole product lifetime. Thus the number of modification cycles is unlimited. The objective of this paper is to study the feasibility of this concept in form of conceptual work. The result of this paper should be better knowledge of the contingency factors and the tactical and strategic implications of embedded open toolkits for user innovation.

2. Literature Review

Product definition has been shown to be critical to new product success [2], [11].The critical question in this phase is how to define the product amidst customer and technology uncertainty. User satisfaction (and thus adoption) with a new product regularly increases with the degree of fit between a user's needs and the characteristics of a product [17]. Conventionally, the manufacturer tries to understand this causal network with detailed information either acquired via market research or assumed via professional knowledge. Previous research has shown that many companies fail to gather this required input in an efficient and effective way [16]. Despite ever increasing methodological knowledge in market research, NPD flop rates continue to rise [8]. Also in the literature on quality management, a major challenge still is to identify customer requirements and to ensure their loss-free transformation into enthusing products. Customers strictly penalize less functional value then expected. On the other hand they honor additional functional value rarely [12].

2.1. Why new product innovations frequently fail

Von Hippel has explained the problems of firms to understand what customers really want by the stickiness of need information [9]. Sticky information is context specific and difficult to formalize and transfer. Stickiness of customer (need) information is a function of multiple factors, including characteristics inherent in the information itself, such as the way information is encoded. Customers often use a different language to describe their demands and think in different design parameters than the manufacturer. Thomke found that firms regularly have to change design parameters as the requirements (representing information about the customers' needs) are not stable during the NPD process [14]. Even in highly specialized industrial markets, customers face an inherent difficulty in accurately specifying their needs at the outset of a NPD project, resulting in a co-evolution of the technological solution with the revision of customer's articulated needs [11]. Research further has shown that familiarity with existing product attributes can interfere with an individual's ability to express needs for novel products [14]. Needs become more refined as users come in direct contact with (a prototype of) a new product.

2.2. The missing link in postponement concepts for NPD

Research has shown that a firm's flexibility to adjust the values of the design parameters close to a product's final launch is positively associated with higher perceived quality and firm performance [11], [15]. One way to increase the design flexibility is postponement in NPD. The basic idea of a postponement strategy is "… to intentionally delay activities rather than starting them with incomplete information input" [18]. Firms should realize benefits from having better information about customers needs before committing semi-finished product concepts to specific design derivates [7]. This view contrasts traditional views of NPD project managers to focus early and "freeze" a product concept in order to reduce the complexity and time of development. But this decision can prevent the flexibility to react on changing customer requirements. In such cases, postponement in NPD should allow a firm to respond better to changing technologies or not-yet defined market requirements.

But while conventional postponement strategies have been described as a major approach to design products that better fit to customer requirements, a fundamental problem remains: Conventional postponement strategies do not eliminate the task of a firm to identify and fully understand the user preferences. There is, however, surprisingly little research in the postponement literature on how to access this information – although the capability of postponement to reduce uncertainty in product planning crucially relies on forecasting skills and measures to predict the (potential) customers' needs. Research only recently has studied the connection between measures to acquire need information and postponement efficiency. But this research remains on the conceptual level [1]. The already mentioned stickiness of need information often prevents firms to access need information correctly. Traditional concepts of postponement cannot solve this problem**.** This paper attempts to fill this gap and therefore suggests a novel way for manufacturers to get access to need information and to incorporate it into product specification.

3. Embedded toolkits as a new concept to increase NPD success and overall product quality

The new idea is to develop a method which enables customers to directly transfer their needs into an artifact that highly corresponds with their needs. This shall be done not before the product is manufactured (similar to engineer-to-order or mass customization; strategies limited in their application due to high cost and a complex on-demand manufacturing system) but after the product has reached the domain of the customer [13]. The concept of embedded open toolkits for user innovation builds on shifting some design decisions of the product development into the customer domain. This strategy isolates the source of uncertainty, i.e. sticky information about user needs, and places it entirely outside the boundary of the manufacturer.

3.1. Requirements for developing embedded open toolkits

The manufacturer's main task of understanding the user needs prior to product launch is postponed into the product usage domain. As the delivered product is meant to transform user needs directly into product specification it should contain:

- a flexible architecture where the values for specific design parameters are not fixed, but adaptable,
- a set of rules about possible combinations of selection of values for this design parameters,
- an interface for individual users to differentiate the product according to their preferences by manipulating the values.

The key requirement of this concept is the user interface that will allow customers to completely adapt and not only configure their product according to their own requirements. It has to be embedded in the product architecture and shift design tasks efficiently and effectively in the user domain. Such an embedded toolkit for user innovation shall equip users with the possible solution capabilities to substitute the lack of professional training and experience. Toolkits are a core enabler of postponing into the user. On a toolkit, a manufacturer lays out an appropriate solution space for users in form of "half-finished" product specifications or more generic solution capabilities and presents this input to customers via an interactive interface [10]. Instead of asking individual users what they want, these toolkits allow users to design a novel product by arranging and combining design parameters and setting values for them and to receive an immediate (simulated) feedback on the potential outcome of their design. Therefore an initial specification of the product hast to be part of the sold product, letting customers use the product without designing themselves but enabling others to change specification and design according to their needs any time after purchase. There has been extensive research on toolkits as a stand-alone instrument in the early stages of NPD. This research serves as an important background for the described concept [3], [4], [5], [10], [13].

However, envisioned is a new kind of toolkit, that is an open but integrated part of a complex product, allowing the real-time modification of this product during its use stage. Such a toolkit also is more than a traditional user interface of a product. It allows users not only to control a given functionality, but to specify the design space of a product module in an innovative way. Consider the example of a dashboard of an automobile: A conventional interface allows the user to interact with the car and control specific functionality. In this approach, the user could design the layout of the dashboard, the functions accessible by it, and also parts of the performance controlled by the customized dashboard. Still, all functionality would stay within the safety requirements of the system and would allow full interface functionality with the rest of the car. Obviously, such a solution has much larger opportunities for users to find an exact product fitting to their needs, but demands much larger requirements in designing the solution space of such a flexible system.

3.2. Transferring principles of open source development into NPD of complex physical products

The initiating idea of this concept was to transfer principles of open source software (OSS) development into the NPD process of complex physical products. OSS projects are characterized by high development flexibility and good fit of the final software design with the users' requirements. It has been shown that involving users in design allows experimentation and trial-and-error learning in their domain. OSS development is characterized by short, experimental and rapid product development with rich user feedback. This process expands the knowledge of the participating users as well. It allows them to determine with a higher degree of confidence exactly which of the available options solves the problems they face and it encourage them to widen their breadth of vision, investigating potential choices outside the current frame of reference. Providing users the opportunity to build what they want instead of asking them what they want and then gathering this information and feeding it back to the manufacturer will enhance the manufacturer's ability to access and process new (need) information for a longer proportion of the development process, an ability that is positively correlated to higher NPD performance.

4. An example of embedded product differentiation

Lutron Electronics is a leading manufacturer of residential and commercial lighting controls and systems. During a strong phase of growth in the 1980s, the company faced strong challenges of an exploding product variety, increasing the NPD. At one point, a rather simple dimmer product was offered with 40 base model numbers and over 300 stock keeping units to accommodate different wattages, voltages, lamp types and colors. This proliferation caused the company to radically redesign its product architecture and to postpone the differentiation in the user domain. Its GRAFIK Eye product incorporates in one product the solution space of the 300 variants of its predecessor. The microprocessor controlled product comes with a simple interface that allows simple and quick modification by the user according to the individual needs. It also substitutes variants which before were the result of a custom engineering process. A core element of Lutron's approach is an easy-to-program interface of its products. Both the initial specification for a

particular environment and the continuous adjustment can be easily performed by the user, based on an interface that supports the trial-and-error problem solving approach.
To define the range and possibilities of built-in adaptability, Lutron evaluates previous custom specifications developed for individual customers (in a conventional engineer-to-order system). Using form and time postponement, Lutron is able to provide custom products within a rather efficient production system. These products, however, are the result of the conventional iterative specification process of customers formulating requests and corporate developers interpreting and transferring these requests in a custom design. While such a process sometimes is required for complex commercial lighting solutions, Lutron learned that over time it could include most of these differentiations into an adaptable product.

5. Implementation and management concept of embedded toolkits

A firm has to manage three distinctive levels to benefit from embedded toolkits, which will also provide the structure for piloting a possible embedded toolkit research project:

- On the product level, modular product family structures have to be created by decomposing the complete product into sub-modules to isolate volatility in the design. Instead of leaving the product architecture as a technical decision, it shall be seen as a potential to improve business performance by partitioning a product structure in a way that the influence of a perturbing variable is isolated to a small portion of the design. Using modular product structures, sub-systems can be adjusted independently to environmental changes. Creating such modular design however is a more complex and costly task compared to designing a closed, complete product. The principles of designing modular products for embedded toolkits are largely unknown.
- On the process level, the introduction of flexible technologies should reduce the economic cost of making fast changes on a product design after more information about the customers' demand has been obtained. But postponement also implies cost of less efficient NPD. Breaking with the traditional freeze rule of NPD often results in more iterations and more complex planning efforts.
- On the management level, a firm has to adapt its management systems for postponement. This includes, for example, progressively lock down requirements, a better framework for making trade-off decisions, better task partitioning, and the integration of all actors along the value chain. The extent to which customer demands can be fulfilled on-time is dependent not only on the responsiveness of the postponed process, but also crucially on the responsiveness of the planning system. The project has to establish the basic requirements of a planning framework for embedded toolkits.

6. Conclusion

This paper proposed the framework of embedded open toolkits as a new way to match new product designs with user preferences. Trough implementing embedded toolkits for specifying product features, product design decisions can be postponed into the user domain. Due to assumed differences in user preferences before and during product usages, a novel understanding of postponement in NPD is outlined.
This framework has several limitations: The idea of embedded open toolkits so far is based on software controlled products. For that reason the concept focuses on a limited product-base. Products also need modular product architectures with appropriate interfaces. Moreover the willingness of customers to modify their product after purchase is assumed and has to be proven. Profitability of integrating embedded toolkits into products and the potential of customer

innovation trough embedded toolkits have to be proven for firms. Thus future research seems promising for several areas. In sum, a deeper understanding of implementing and managing embedded open toolkits is still needed. Conducting a multi-segment study on a differentiated product base can gain this understanding. This is the direction of our further research.

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